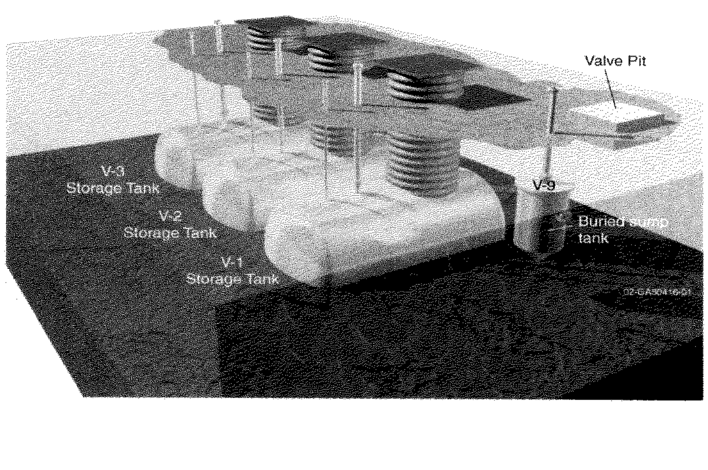
INEEL/EXT-03-00438
Project # 22901

Conceptual Design Report for Ex Situ Chemical Oxidation/Reduction and Stabilization of the V-Tanks at Waste Area Group 1, Operable Unit 1-10

June 2003



Idaho National Engineering and Environmental Laboratory
Bechtel BWXT Idaho, LLC

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June 2003

Idaho National Engineering and Environmental Laboratory

Idaho Falls, Idaho 83415

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Conceptual Design Report for Ex Situ Chemical Oxidation/Reduction and Stabilization of the V-Tanks at Waste Area Group 1, Operable Unit 1-10

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Approved by

James J. Jessmore OU-10 V-Tanks Project Manager	6/16/03 Date
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ABSTRACT

Four underground, stainless steel tanks (collectively known as the V-Tanks) located at Test Area North (TAN) and part of Operable Unit (OU) 1-10 were installed in 1953 and operated as part of a system to collect and treat radioactive liquid effluents from TAN operations. Although the V-Tanks have been out of service since 1985, they still hold contaminated liquid and sludge. V-Tank remediation is an essential element of the Idaho Completion Project (ICP).

This report details the conceptual design for remediation of the V-Tank waste. Ex situ chemical oxidation/reduction/stabilization (ES-CO/R/S) was chosen as the preferred remediation technology after a technical evaluation of seven possible remediation alternatives. ES-CO/R/S involves consolidating the waste into two tanks before removing the waste for treatment. After the waste has been consolidated, it will be removed and chemically oxidized in above ground reaction vessels to destroy the organic contaminants. Once the waste has been oxidized, it will be stabilized with grout in approved containers and shipped to the INEEL CERCLA Disposal Facility (ICDF) for disposal.

Following the treatment and disposal of the tank contents, the tanks will be decontaminated, removed, and disposed. Contaminated soil around the V-Tanks will also be removed and disposed. (This conceptual design report details the design for the remediation of the tank contents. The decontamination, removal, and disposal of the tanks and the surrounding soil is not part of this conceptual design)

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ACRONYMS

AGTST	above ground temporary storage tank
ALARA	as low as reasonably achievable
ARAR	applicable or relevant and appropriate requirement
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CDR	Conceptual Design Report
ES-CO/R/S	Ex Situ Chemical Oxidation/Reduction/Stabilization
GC/MS	gas chromatograph/mass spectrometer
GCD	greater confinement disposal
HEPA	High-Efficiency Particulate Air (filter)
I/O	input/output
ICDF	INEEL CERCLA Disposal Facility
INTEC	Idaho Nuclear Technology and Engineering Center
LDR	land disposal restriction
LSC	Life Safety Code
MFPJMS	Mobile Fluidic Pulse Jet Mixing System
NESHAP	National Emission Standards for Hazardous Air Pollutants
OPC	other project cost
ORNL	Oak Ridge National Laboratory
OU	Operable Unit
P&ID	piping and instrumentation diagram
PCB	polychlorinated biphenyl
PCE	tetrachloroethylene

PID	proportional integral derivative
PLC	programmable logic controller
QAPD	Quality Assurance Program Description
RCRA	Resource Conservation and Recovery Act
RI/FS	remedial investigation/feasibility study
SAR	Safety Analysis Report
SO	systems operability
SVOC	semivolatile organic compound
TAN	Test Area North (formerly ANP)
TCA	trichloroethane
TCE	trichlorethene
TEC	total estimated cost
TFR	Technical and Functional Requirement
TSCA	Toxic Substances Control Act
UCL	upper confidence limit
UHC	underlying hazardous constituent
UTS	Universal Treatment Standards
VOC	volatile organic compound
WAC	waste acceptance criteria

Conceptual Design Report for Ex Situ Chemical Oxidation/Reduction and Stabilization of the V-Tanks at Waste Area Group 1, Operable Unit 1-10

1. INTRODUCTION

- The V-Tanks are four underground stainless steel tanks located at TAN
- Seven possible alternatives were studied for V-Tank remediation.
- Ex situ Chemical Oxidation/Reduction/Stabilization was chosen as the preferred alternative.
- V-Tank remediation is an essential element of the Idaho Completion Project.

This Conceptual Design Report (CDR) details the conceptual design of the ex situ chemical oxidation/reduction/stabilization (ES-CO/R/S) process for remediation of the Test Area North (TAN) V-Tanks. ES-CO/R/S was identified as the preferred alternative for V-Tank remediation in the New Proposed Plan for the V-Tank contents at Test Area North Operable Unit (OU) 1-10 (INEEL 2003c). An amendment to the OU 1-10 Record of Decision is being prepared to make a final decision on the remedy for treating V-Tank contents. This project is an essential element of the overall Idaho Completion Project.

The purpose of this project is to remove, treat, and stabilize the waste currently stored in the V-Tanks so that it can be disposed of at the INEEL CERCLA Disposal Facility (ICDF) This CDR includes the conceptual design of sludge removal, treatment, preparation for at ICDF

The four stainless steel s collectively known the "V s" were stalle AN as part the system designed to collect and treat radioactive liquid effluents from TAN erations The V Tanks are underground stainless steel associated with Operable Unit (OU) These four are identified V. V-2, V-3, and V-9, with V-1, V-2, and V-3 identical in shape and size and V-9 having a unique, smaller shape (see Figure 1). Tanks V-1, V-2, and V-3 were used for storage, while Tank V-9 was used as a primary separation tank to separate sediment and sludge from the liquid waste before transferring that waste to V-1, V-2, or V-3. Each of the V-Tanks currently contains a liquid and sludge layer, and all of the V-Tanks lack secondary containment. The tops of Tanks V-1, V-2, and V-3 are approximately 10 feet below grade, while the top of Tank V-9 is approximately 7 feet below grade.

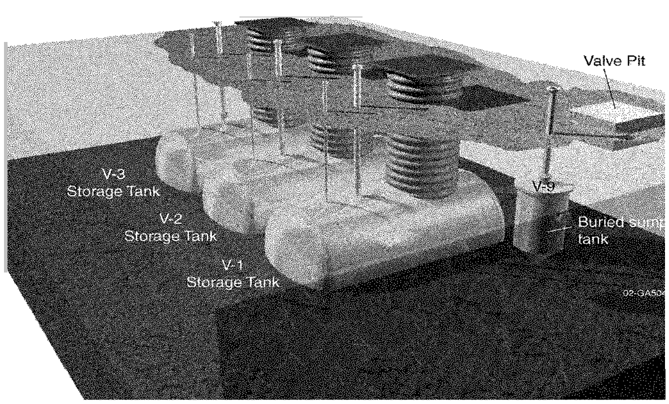

Figure 1. V-Tank configuration.

Tank V-9 is within Technical Support Facility (TSF) 18, while Tanks V-1, V-2, V-3, are within TSF-09.

1.1 Background

The V-Tanks and associated piping were installed in 1953 and became operational in 1958. The tanks were designed to collect and store liquid radioactive waste at TAN. The waste was stored in the underground tanks then treated in the evaporator system located in TAN-616. Tanks V-1 and V-3 became inactive in the early 1980s. Tank V-2 was taken out of service in 1968 after a large quantity of oil was discovered in the tank. The oil was removed in 1981. In 1982, the excess free liquid was removed from the V-Tanks. Additional wastewater was reportedly added to Tank V-3 through 1985. Starting in 1985, all low-level radioactive waste at TAN was rerouted to the TAN-666 tanks through a piping modification in the TAN-1704 valve pit. The piping modification stopped intentional discharge to the V-Tanks in 1985. There is no evidence that sludge accumulating in the tanks was removed during or after site operations (DOE-ID 1997).

1.1.1 Facility Functions and Operations

Tanks V-1, V-2, and V-3 are stainless steel tanks measuring 3 m (10 ft) in diameter, 5.9 m (19.5 ft) long, and buried approximately 3 m (10 ft) below ground surface. The tanks have 50.8-cm (20-in.) manholes that are accessible through 1.8-m (6-ft) diameter culverts installed in 1981 (DOE-ID 1997). Each tank is equipped with three subsurface influent lines and one subsurface effluent line. The tanks received radioactive wastewater via an influent line from Tank V-9. The remaining influent lines include a caustic line used to neutralize the waste prior to transfer to TAN-616 and a return flow line from the TAN-616 pump room. Tank V-3 has an additional inlet line from the TAN-615 east and west sumps. A single effluent line on each tank is routed to the TAN-616 pump room and evaporator system.

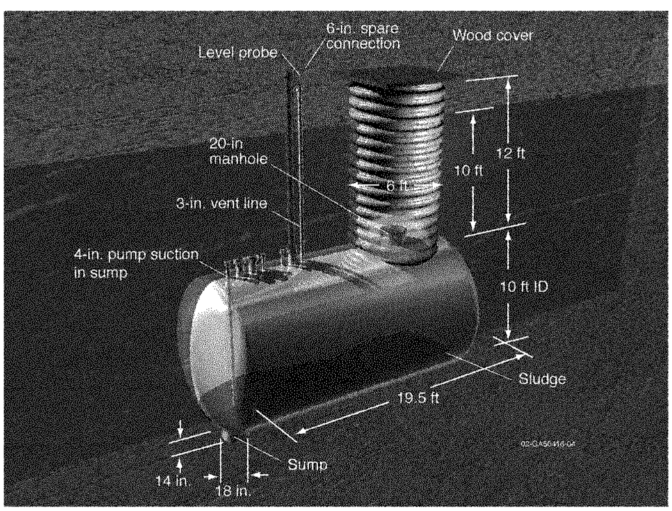

Figure 2. Tanks V-1, V-2, and V-3.

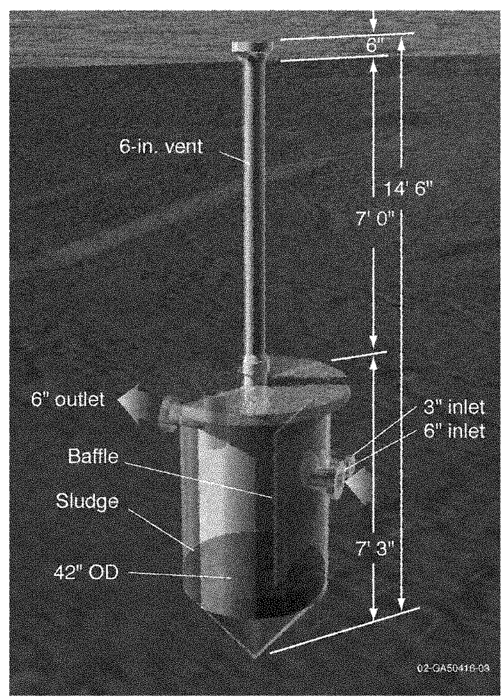

Figure 3. Tank V-9.

Liquid level measurements, recorded since April 1996, track the fluid levels in V-1, V-2, and V-3. Measurements since 1996, and anecdotal information preceding 1996, indicated an increase in the liquid level in Tank V-3 during the spring. This tank level stopped increasing in 2001. All lines, valves, and drains associated with the TSF-09 tanks are either plugged or identified as inactive; therefore, the increase is believed to be from spring snowmelt and runoff entering the tank through the manway above the entrance to Tank V-3. Liquid level measurements in Tanks V-1 and V-2 have remained relatively constant (DOE-ID 1997).

The volume of liquid and sludge in the V-Tanks has been estimated based on the results of the 1996 RI/FS sampling (DOE-ID 1997). Table 1 summarizes the four V-Tank's capacities and current contents (i.e. reflecting liquid level increases since the RI/FS).

Table 1. V-Tank capacities and current contents (gallons).

Tank	Capacity	Liquid Volume	Sludge Volume	Total Volume
V-1	10,000	1,164	520	1,684
V-2	10,000	1,138	458	1,596
V-3	10,000	7,660	652	8,312
V-9	400	70	250	320
Total	30,400	10,032	1,880	11,912

Based on 1980 x-ray diffraction data, the 1993 Track 2 investigation, and the 1996 Remedial Investigation/Feasibility Study (RI/FS) sampling results (DOE-ID 1997), the major V-Tank constituents[1] are shown in Table 2.

A pre-conceptual design study (INEEL 2002) addressed seven possible alternatives for remediating the V-Tanks and treating the contaminants shown in Table 2. A subsequent Technical Evaluation study (DOE-ID 2003) selected ES-CO/R/S as the preferred remediation technology.

[1] The data in Table 2 differs from data in previous V-Tank documents because it reflects recent validation efforts documented in EDF-3791.

Table 2. Major Tank Constituents of Interest.

Constituent	Tank V-1	Tank V-2	Tank V-3	Tank V-9	Average
Inorganics	ppm	ppm	ppm	ppm	ppm
Aluminum (Al)	5.27E+02	1.12E+03	2.58E+02	2.69E+03	4.83E+02
Antimony (Sb)	1.14E+00	1.13E+00	3.63E-01	1.15E+01	9.01E-01
Arsenic (As)	5.83E-01	6.41E-01	1.44E-01	1.52E+00	3.13E-01
Barium (Ba)	8.31E+00	6.97E+00	2.02E+00	2.99E+02	1.23E+01
Beryllium (Be)	1.60E+00	8.03E-01	2.57E-01	2.02E+01	1.10E+00
Cadmium (Cd) (mean)	3.89E+00	4.14E+00	8.62E-01	2.18E+01	2.34E+00
Cadmium (Cd) (90% UCL)	6.41E+00	7.36E+00	1.06E+00	2.92E+01	2.76E+00
Calcium (Ca)	1.78E+03	2.25E+03	6.90E+02	6.74E+03	1.23E+03
Chlorides (Cl)	2.07E+02	1.02E+02	7.42E+01	3.97E+02	1.06E+02
Chromium (Cr)	5.25E+02	1.12E+03	2.58E+01	1.88E+03	2.98E+02
Iron (Fe)	2.63E+03	5.60E+03	1.61E+03	1.46E+04	2.67E+03
Lead (Pb)	4.88E+01	5.58E+01	1.21E+01	4.53E+02	3.61E+01
Magnesium (Mg)	2.64E+03	2.25E+03	9.81E+02	9.01E+03	1.62E+03
Manganese (Mn)	7.02E+02	2.24E+03	3.23E+02	4.26E+03	7.49E+02
Mercury (Hg) (mean)	6.02E+01	6.32E+01	1.92E+01	1.67E+03	7.92E+01
Mercury (Hg) (90% UCL)	7.84E+01	7.57E+01	2.27E+01	1.97E+03	8.71E+01
Nickel (Ni)	1.57E+01	1.42E+01	4.24E+00	3.19E+02	1.64E+01
Phosphorus (P)	9.62E+03	1.35E+04	4.19E+03	4.04E+04	7.26E+03
Potassium (K)	1.87E+02	2.89E+02	5.77E+01	8.54E+03	3.56E+02
Silicon (Si)	2.10E+04	2.24E+04	6.13E+03	7.06E+04	1.23E+04
Silver (Ag)	7.70E+00	8.63E+00	1.18E+00	5.22E+02	1.84E+01
Sodium (Na)	4.99E+02	3.53E+02	1.69E+02	1.92E+03	2.92E+02
Sulfates (SO4)	1.82E+02	2.69E+01	2.31E+01	3.60E+01	4.64E+01
Zinc (Zn)	8.77E+02	7.68E+01	4.31E+01	1.40E+03	2.06E+02
Volatile Organic Compounds	ppm	ppm	ppm	ppm	ppm
TCE (mean)	3.77E+00	3.06E-01	2.09E-01	1.45E+04	4.26E+02
TCE (90% UCL)	1.46E+01	5.14E-01	2.62E-01	2.62E+04	7.49E+02
PCE (mean)	4.37E+02	1.38E+02	3.63E+01	4.26E+02	1.18E+02
PCE (90% UCL)	8.34E+02	1.61E+02	4.09E+01	5.53E+02	1.75E+02
TCA (mean)	2.46E-01	9.67E-02	2.91E-02	1.77E+03	5.21E+01
TCA (90% UCL)	8.21E-01	3.01E-01	8.45E-02	2.54E+03	8.59E+01
Semivolatile Organic Compounds	ppm	ppm	ppm	ppm	ppm
Araclor-1260 (mean)	3.45E+01	2.44E+01	1.00E+01	9.59E+01	1.79E+01
Araclor-1260 (90% UCL)	4.69E+01	2.96E+01	1.26E+01	1.38E+02	2.04E+01
BEHP (mean)	9.18E+02	5.89E+02	3.38E+02	3.45E+02	4.54E+02
BEHP (90% UCL)	1.27E+03	1.03E+03	3.89E+02	4.96E+02	5.28E+02
Radionuclides	nCi/g	nCi/g	nCi/g	nCi/g	nCi/g
Total TRU (mean)	1.09E+01	4.02E+00	2.03E+00	2.64E+01	4.28E+00
Total TRU (90% UCL)	1.32E+01	4.89E+00	2.28E+00	4.89E+01	4.77E+00
Sr-90	1.52E+03	3.20E+03	1.51E+03	5.18E+03	1.84E+03
Cs-137 (mean)	1.74E+03	1.82E+03	5.28E+02	4.48E+03	9.88E+02
Cs-137 (90% UCL)	2.45E+03	2.66E+03	6.28E+02	5.84E+03	1.14E+03
Other	ppm	ppm	ppm	ppm	ppm
Total Carbon	1.67E+04	3.34E+04	7.99E+03	9.19E+03	1.27E+04

1.2 Mission Need

The WAG 1 Project is responsible for managing and remediating sites shown to pose an unacceptable risk to human health and/or the environment. V-Tank remediation is directed in the OU 1-10 Final Record of Decision for Test Area North (DOE-ID 1999) as amended.

Remediation of the V-Tanks is an essential element of the Idaho Completion Project to cleanup and close Department of Energy (DOE) Environmental Management facilities at the INEEL.

2. PROJECT BASIS

2.1 Key Project Assumptions

Key project assumptions are listed in Appendix A. These assumptions were used in developing the project scope, work plan, cost estimate, and schedule for the conceptual design. The project work plan, cost estimate, and schedule will be impacted if these assumptions prove to be invalid.

Remediation Approach

- Waste will be removed, treated, and prepared for disposal at ICDF.
- Treated waste will meet the ICDF waste acceptance criteria.
- Waste treatment complies with CERCLA, State of Idaho, NESHAP, RCRA, and TSCA requirements.

2.2 Technical and Functional Requirements

The Technical and Functional Requirements (TFR) for ES-CO/R/S of the V-Tanks at Test Area North Project are listed in TFR-222 (Appendix B). The TFR establish the technical baseline for the project and capture the requirements for safely removing and treating the contents of the V-Tanks and preparing it for disposal at ICDF. The waste disposed of at ICDF will be in accordance with ICDF waste acceptance criteria (WAC) with the approval of the ICDF facility manager.

2.3 Applicable or Relevant and Appropriate Requirements

The applicable or relevant and appropriate requirements (ARARs) associated with ES-CO/R/S can be found in the project TFR document (see Appendix B). V-Tank remediation complies with requirements from the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the State of Idaho, the National Emission Standards for Hazardous Air Pollutants (NESHAP), the Resource Conservation and Recovery Act (RCRA), and the Toxic Substances Control Act (TSCA).

3. PROJECT TECHNICAL DESCRIPTION

Remediating the V-Tanks using ES-CO/R/S is a complicated process. This section describes the remediation process along with pertinent information and technical uncertainties that influenced design decisions.

Section 3.1 provides an overview of the project as a whole and section 3.2 describes the project operations. Sections 3.3 to 3.9 look at the design in more detail and offer insights into the reasoning behind conceptual design decisions. These sections focus on the chemical, mechanical, civil, and electrical engineering aspects of the conceptual design as well as the regulatory and safety requirements. Finally, section 3.10 provides an overview of the technical uncertainties associated with V-Tank remediation using ES-CO/R/S.

Technical Description

- Oxidation converts organic contaminants to carbon dioxide, water, and halide salts.
- Grouting reduces the leachability of metals and produces a solid waste form.
- Solid V-Tank waste will be shipped to ICDF for disposal.

3.1 Project Description

The original V-Tank remediation plan (DOE-ID 2001) included shipping the sludge phase of the tank contents to an out-of-state commercial facility for treatment. However, the identified out-of-state treatment facility is no longer available; therefore, the remediation plan was reevaluated and seven alternative remediation technologies were detailed in pre-conceptual designs (INEEL 2002) and evaluated. ES-CO/R/S was chosen as the preferred alternative for V-Tank remediation.

Chemical oxidation, the organic treatment phase of ES-CO/R/S, is an ambient pressure, low temperature (95°C) treatment process that employs strong oxidants to convert organic contaminants in solids and liquids to carbon dioxide, water, and halide salts.

After oxidization, the material undergoes a stabilization treatment process, which reduces the leachability of hazardous metals and produces a solid waste form that can be disposed at the INEEL CERCLA Disposal Facility (ICDF).

ES-CO/R/S of the V-Tanks involves four major steps:

1. Consolidation of the V-Tank waste into two of the four tanks. Some liquid is decanted for process purposes (FY 2004).
2. Sludge waste is removed from the tanks and treated using an above ground oxidation/reduction system (FY 2005).
3. The treated waste and excess decanted water is grouted to achieve a stabilized, solid waste form. (FY 2005).
4. The solid waste is packaged and shipped to ICDF for disposal (FY 2005).

3.1.1 Proposed Construction Methodology

Prior to operations, the existing area surrounding the V-Tanks will be cleared, grubbed, and graded. The surface will be covered with a 4-inch layer of compacted gravel and sand to provide a working surface. The work area will be bounded by an earth containment berm. The process area will be provided with secondary containment by a liner system. The liner will extend over the containment berm surrounding the area. The process equipment will be brought in on skids and positioned using mobile cranes.

Tanks V-1, V-2, and V-3 will be prepared for treatment by drilling down with an air lance and vacuum system to the tank over the sump. A drill rig will be brought in to install a casing and tank seal. The tank will then be drilled above and adjacent to the tank sump to allow access for pumping the tank sumps from the surface.

An assumption has been made that TAN-616 will be removed and the underlying soils will be treated, if required, to facilitate the process described in this conceptual design. The layout for the equipment and the containment area were chosen based on this assumption. If this assumption proves to be invalid, a different arrangement will be required to equipment placement to accommodate the building and underlying soils.

3.1.2 Major Equipment

Major equipment that will be used in ES-CO/R/S is listed below with a brief description. A detailed description of all major equipment is provided in section 3.4. Figures 4 and 5 show the equipment layout at the work area.

- **An above ground temporary storage tank (AGTST)** will be used as a temporary storage for up to 6000 gallons of supernate currently residing in Tank V-3.
- **A Mobile Fluidic Pulse Jet Mixing System (MFPJMS)** will be used to transfer tank contents between the V-Tanks, the treatment system, the above ground temporary storage tank, and the grout/stabilization system. The MFPJMS is specially designed to homogenize mixtures of sediments and liquids so that they can be pumped out of tanks in a near homogenous manner.
- **A waste treatment system** will be used to perform the chemical oxidation/reduction phase of the project. This system consists of two 500 gallon reaction vessels operated in a staggered arrangement. A chemical additive system is also included.
- **An single off-gas treatment system** will treat any off gas created during waste treatment before the off gas is released into the atmosphere.
- **A grout/stabilization system** will be used to stabilize the oxidized waste prior to disposal at the ICDF.

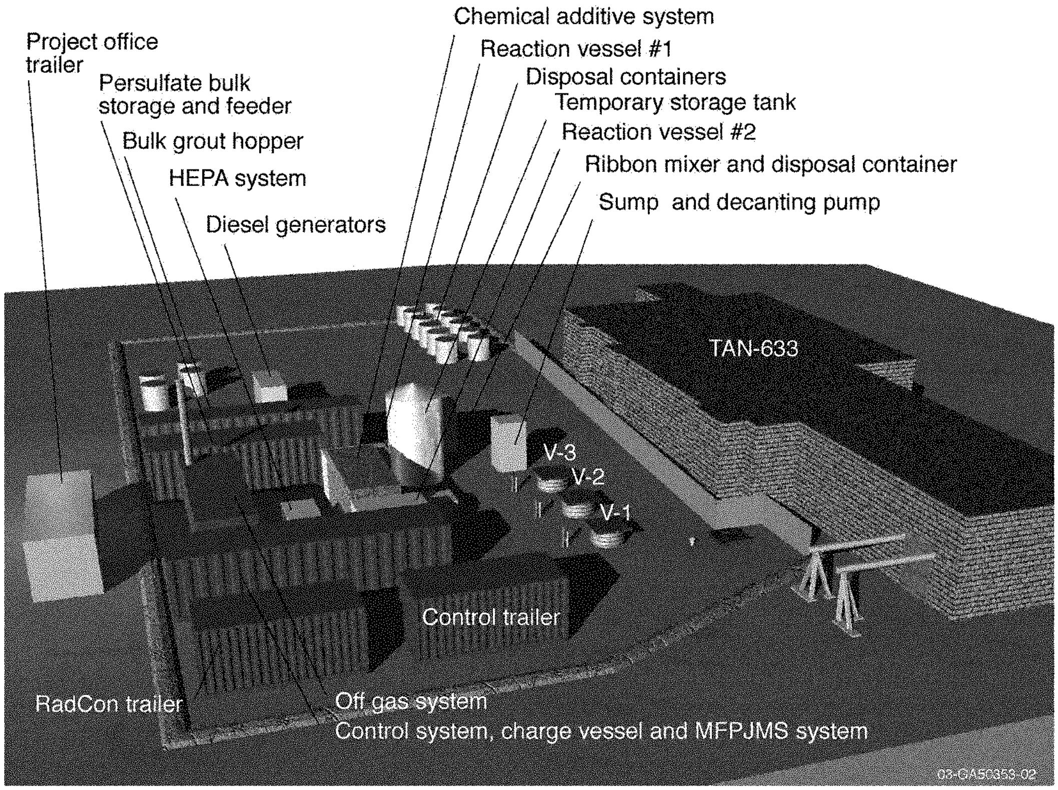

Figure 4. Equipment layout for V-Tank remediation.

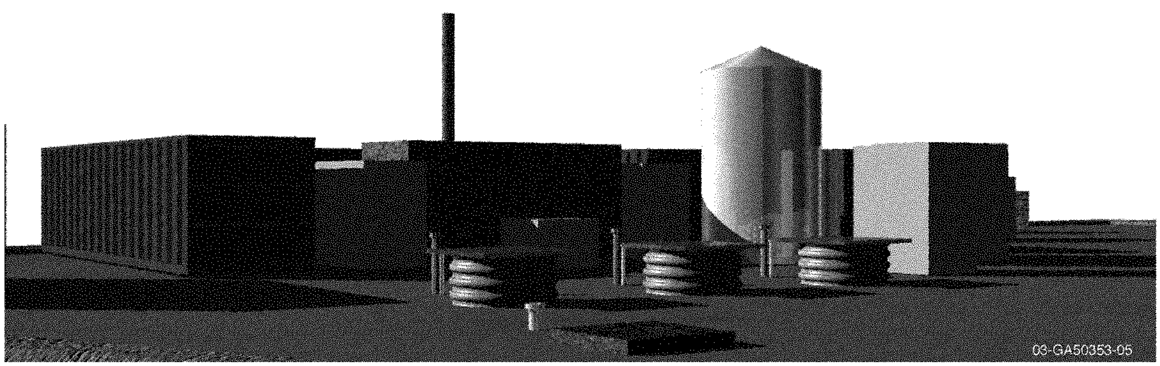

Figure 5. Ground level view of the remediation process equipment.